Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

Reserve
A464.4
EL8

UNITED STATES
DEPARTMENT OF AGRICULTURE
LIBRARY

Reserve
BOOK NUMBER A464.4
EL8

CHEMICAL CONTROL OF HARDWOOD BRUSH FOR GRASS PRODUCTION*

By Harry M. Elwell**
Soil Conservationist
Guthrie, Oklahoma

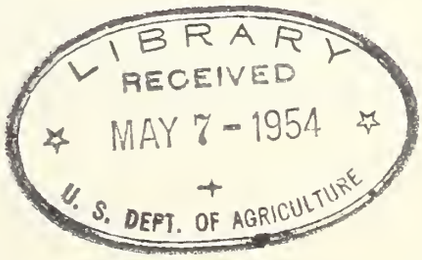
Shrubby brush of hardwood species have choked off production on millions of acres of range land in the southwest. Their severe competition for moisture, sunlight, and plant food greatly reduces growth of the better forage plants and represents one of the greatest detriments to range forage production. Droughts have been common in this area, resulting in fire damage and overgrazing. These factors depressed grass production, resulting in the rapid expansion of brush over these once productive grass lands.

Brush control investigations on oaks and other hardwood species were started on the Red Plains Conservation Experiment Station at Guthrie, Oklahoma, in 1935. The first work was done with hand tools, but since then various methods have been tried. Chemicals were introduced into these studies in 1945, and the studies have now spread to various parts of the state through field trial tests in soil conservation districts. This report evaluates the effectiveness of the chemicals investigated.

---

*Prepared for presentation before American Society of Agronomy and Soil Science Society of America, Dallas, Texas, November 17, 1953. Contribution from the United States Department of Agriculture, Bureau of Plant Industry, Soils, and Agricultural Engineering, and Oklahoma A. & M. College. Approved for publication October 13, 1953 by the Director of the Agricultural Experiment Station of Oklahoma A. & M. College and November 6 by the Chief of the Bureau of Plant Industry, Soils, and Agricultural Engineering.

** Contribution from the Bureau of Plant Industry, Soils, and Agricultural Engineering and Oklahoma A. & M. College. Most effective cooperation was also given by chemical and meat processing companies, manufacturers and operators of spraying equipment, farmers, and the Flying Farmer's Research Foundation.



SPECIES OF HARDWOODS

The major species of hardwoods studied were those associated with the post oak-blackjack types of brush and small trees. The predominating species were blackjack (Quercus Marilandica Muench.), post oak (Quercus Stellata Wang., formerly Q. minor Sarg.), white oak (Quercus Alba L.) dwarf chinquapin (Quercus prinoides Wild.), and pin oak (Quercus palustris Muench.). Other hardwoods often intermingled with them were: hickories (mostly Hicoria alba /L./ Britton or Hicoria buckleyi /Dur./ Sud), white and winged elms (Ulmus americana L. and Ulmus alata Michx.), Osage orange (Toylon pomiferum Rafn.), black and honey locusts (Robinia pseudo-acacia L. and Gleditsia Triacanthos L.), hackberry (Celtis occidentalis crassifolia /La M./ Gray), Chittamwood (Bumelia lanuginosa /Michx./ Persoon), Western Crab Apple (Malus ioensis palmeri Rhed.), black willow (Salix nigra Marsh.), cottonwood (Populus deltoices virginiana /Cast./ Seed.), sassafras (Sassafras varifolium /Sal./ Kun.), Dogwood (Cornus asperifolia Mich.), redbud (Cercis canadensis L.), and persimmon (Diospyros virginiana L.).

Along with this type of vegetation were also areas of small shrubs and brambles. They were composed of sumac (Rhus copallina, L.), sand plum (Prunus angustifolia Marsh.), buckbrush (Symphoricarpos orbiculatus Moench.), blackberries (Rubus spp.), wild roses (Rosa spp.), and greenbriers (Smilax spp.).

METHODS OF CONTROL

Methods of applying chemicals to control brush for grass production vary greatly because of the wide variety of woody plants and grasses, and wide differences in climatic and soil conditions (3). The methods tried were foliage sprays, basal-bark, soil, and stump treatments. These methods have all given satisfactory results when used on brush within the limits for which each method is best suited. It appears unlikely that any one method can be developed to operate satisfactorily under all conditions and with all types of brush. Before deciding the method to use on a given area, a survey should be made to determine the size and different kinds of species present. The various species and plants are not equally affected by chemicals. Therefore, a list of susceptibility of various species the herbicides will be helpful. This information can be obtained from the North Central Weed Research reports and from chemical companies.

Foliage Sprays

The low-volatile esters are not as hazardous to sensitive crops as other esters. Foliage sprays of these and other chemicals have been applied on the oak types of brush with motor-driven sprayers, air-blast machines, and

the airplane. The most effective and satisfactory time to spray was when plants have just developed full leaf size, while photosynthesis was active. Best results have been obtained with selective herbicides when the soil moisture was adequate for ideal growing conditions, humidity fairly high, and there was a uniform air temperature of 60 to 80 degrees Fahrenheit with little or no wind.

Under humid conditions, spray solutions of water have been satisfactory for selective herbicides and ammonium sulfamate "Ammate". But, when dry or more arid conditions were encountered, the addition of 10 gallons of diesel oil to each 100 gallons of spray solution of selective herbicides has increased the kill. The effectiveness of water solutions of ammonium sulfamate was also improved by the addition of a spreader-sticker material recommended by the manufacturer.

When mixed species of hardwoods were sprayed, some plants were resistent to the herbicides. Re-treatments were therefore necessary. Better results were sometimes obtained when the follow-up treatments were made with a chemical other than the one originally used.

Sprouts from stumps were difficult to kill with 2,4-D or 2,4,5-T foliage sprays. This was particularly true for sprouts that were not well established on the old roots of the original plants. Ammonium sulfamate foliage sprays were usually more effective in treating young sprouts. However, it was generally advisable to let the sprouts grow for more than two years before attempting to treat them.

Although the results from the earlier tests were often erratic and required more re-treatments, the older formulations of 2,4-D and 2,4,5-T have killed oak brush (Table 1) when applied in large volume applications on fully leafed brush. These plots were sprayed with a hydraulic sprayer until the foliage was wet, using two pounds of acid in 100 gallons of water. Effective control of this oak brush was obtained from several of these treatments.

The effectiveness of some of the new formulations of the low-volatile ester herbicides is given in Table 2. The native oak brush on this area was crushed and broken down with a Marden brush cutter in May, 1947. The regrowth, when sprayed in May, 1951, with selective herbicides in low-volatile esters, was quite dense, and ranged in height up to 10 feet. In this particular study, very effective control was obtained from only one application.

Large-scale field trial studies with airplane applications on oak brush were started in June, 1952, at four locations in Oklahoma. These investigations were made cooperatively by the Production and Marketing Administration, Soil Conservation Service, and Bureau of Plant Industry, Soils, and Agricultural Engineering of the U. S. Department of Agriculture; Aerial Applicator's Association; Oklahoma A. and M. College; and ranchers. Two

TABLE 1. -- Effect of Selective Herbicides in Foliage Sprays on Oak Brush, Guthrie, Oklahoma[1]/

Kind of Chemical	Date and Treatment		Percent of Brush Remaining October 1953
	Sprayed	Re-Treated	
Untreated (Check)	--	--	100.0
Salts of 2,4-D			
Sodium	April 1946	May 1947	34.2
Ammonium	July 1946	"	26.1
"	May 1947	May 1948	5.5
Amines of 2,4-D			
Triethanol	April 1946	May 1947	77.5
"	May 1946	"	25.6
Esters of 2,4-D			
Ethyl	June 1945	May 1947	8.4
"	April 1946	"	26.8
Butyl	"	"	38.6
"	May 1947	May 1948	7.7
Isopropyl	"	"	7.7
"	July 1947	"	3.0
"	May 1947	"	9.5
Ester of 2,4,5-T			
Isopropyl	May 1947	May 1948	1.4

1/ There was originally an average of 10,396 trees and shrubs per acre of the post oak-blackjack type of brush. Plots were each one-fourth acre in size.

of these tests were located in Osage County, one in Creek County, and the other in Grady County. One of the sites in Osage County occupied only 80 acres, but each of the others covered 160 acres.

A selective herbicide of low-volatile ester was applied on plots each 20 acres in size. This treatment was made in June, 1952, at rates of one, two, and three pounds of acid per acre. Some of the plots were re-treated in June, 1953.

TABLE 2. -- Effect of Low-Volatile Ester Herbicides in Foliage Sprays on Oak Brush; Guthrie, Oklahoma[1]/

Kind of Chemical Applied[2]/	Pounds of Acid in 100 Gallons of water	Percent of Brush Remaining October 1953
Untreated (Check)	--	100.0
2,4-D	2	14.6
"	3	12.1
"	4	12.7
2,4-D - 2,4,5-T	2	13.5
"	3	7.6
"	4	9.8
2,4,5-T	2	10.5
"	3	6.7
"	4	9.2

1/ There was originally an average of 17,274 trees and shrubs per acre of the post oak-blackjack type of brush.

2/ May, 1951, on four-year old oak sprouts.

Evaluations of the effectiveness on brush control and amount of grass produced were made of this study in September, 1953. The detailed results will be given in a separate report. The general conclusions were that the single applications, even at highest rates, were not controlling the brush sufficiently. The re-treatments, however, even at the lower rates, were effective and permitted the grass to establish a good cover, where properly managed. There was enough grass the second year for moderate use. Weed control on the re-treated areas was excellent, but further study is needed to determine the full value of the lower rate on re-sprouting. The 2,4,5-T appeared to be more effective than the mixture of 2,4-D and 2,4,5-T.

In earlier tests, diesel oil was most commonly used for airplane spraying. Some of the tests made in June, 1952, however, with water-oil emulsions, at a rate of 4 parts of water to one of oil, appear to be about as effective as the oil treatments.

Airplane spraying during the winter months was not effective on hardwood species. Several tests were made during the winter of 1949 and 1950. The rate of application of 2, 4-D and 2, 4, 5-T ranged from 1 1/2 to 3 pounds per acre in diesel oil in quantities of 5 to 15 gallons.

Non-Selective Herbicides and Other Materials. The non-selective herbicide ammonium sulfamate "Ammate" has also been effective on hardwood species (Table 3). The rate of application used was 3/4 to 1 pound per gallon of water. This material was safer to use along roadsides, fence rows, orchards, etc., adjacent to crops sensitive to the selective herbicides. It was also effective during a longer period of the growing season.

TABLE 3. -- Effect of Ammonium Sulfamate "Ammate" in Foliage Sprays on Oak Brush, Guthrie, Oklahoma[1]/

Date and Treatment[2]/		Percent of Brush Remaining October 1952
Sprayed	Re-Treated	
Untreated		100.0
May 1945	Sept. 1945	3.0
Sept. 1945	May 1946	6.0
May 1946	July 1946	5.8
July 1946	May 1947	5.6
May 1947	May 1948	3.7

1/ There was originally an average of 10,396 trees and shrubs per acre of the post oak-blackjack type of brush.

2/ This chemical was applied on plots one-fourth acre in size at the rate of one pound per gallon of water.

Substantial savings in material were made when ammonium sulfamate was applied with an air-blast sprayer. This machine has produced as effective a kill of this oak brush as the hydraulic sprayer, with only one-third to one-half the quantities of ammonium sulfamate and water.

Other materials tried included three types of borax, a preparation of silicofluoride containing a trace of 2, 4, -D, and TCA sodium salt (trichloracetic acid). The borax compounds were not effective in foliage sprays but did kill oak brush when the powder was applied near the roots of each plant. TCA and silicofluoride, applied at the rate of three-fourth pounds per gallon of water, defoliated the oak. There was a considerable recovery of plants sprayed with TCA, but silicofluoride killed a high percentage of both the oak and grass.

Basal-Bark Treatment

Basal-bark treatments consist of completely wetting the bark around the lower part of each tree to the point of runoff. Knapsack sprayers, fire fighters, and powered orchard-type sprayers were used for this purpose. The spray materials were applied in bands 20 to 30 inches wide around the lower part of saplings and smaller trees, and in axe incisions of trees larger than five inches in diameter. Other powered equipment for this purpose now being investigated includes an experimental unit made by a private company at Oklahoma City. It consists of a framework mounted around the front and sides of a small farm tractor. Nozzles mounted in the frame direct a stream of solution at the base of the plants.

Low-Volatile Esters and Other Selective Herbicides. The low-volatile esters of selective herbicides have been the most effective for basal-bark treatments. High percentages of both the tops and roots of the oak brush were killed with these esters in oil. In some places, however, more than one treatment was required to eliminate the brush. Summer applications were not as effective as winter treatments made from December 15 to March 15. These conclusions were made from tests with various selective herbicides in basal-bark treatments since 1949 on approximately 400 plots. The formulations included amines and esters. The esters were of isopropyl, butyl, the low-volatile types butoxy ethanol, and propylene glycol butyl ether (Table 4).

The low-volatile ester of 2,4,5-T, applied in concentrations of 10.5 pounds of acid in 100 gallons of diesel oil. was satisfactory and produced a high degree of kill. Quite similar results were also obtained with 2,4-D of these esters applied in higher concentrations. Amines were also tested and they were not as effective as ester formulations for basal-bark treatments on oak.

Where emulsions of oil and water of either amine or ester formulations were applied, very poor results were obtained. The effectiveness of these selective herbicides was not improved by the addition of TCA or pentachlorophenyl.

Spraying the entire tree and brush during the dormant season with these various herbicides was not effective.

Non-Selective Herbicides. The non-selective herbicide tried was ammonium sulfamate "Ammate". Where ammonium sulfamate was applied in axe incisions around small oak trees of 10 inches or less in diameter during late summer, good results were obtained. Crystals, as well as a solution of 5 pounds of this material per gallon of water, were effective.

Soil Treatment

CMU (3-P-Chlorophenyl 1, 1-Dimethylurea) was applied on oak brush during the spring and summer of 1951, 1952, and 1953. Different amounts of this material was applied on and in the soil at various distances from the base of the plant in the form of dry powder, water solutions, and pellets. The concentration of the powder was 80 percent and that of the pellets only 25 percent

TABLE 4. -- Effect of Various Esters of 2, 4-D or 2, 4, 5-T in Basal-Bark Treatments on Oak Brush[1]/

Type of Ester	Kind of Chemical	Pounds Acid per 100 gallons of oil	Percent of Dead tops[2]/ October 1953
Butyl	2, 4-D	17.0	20
"	"	68.0	100
Isopropyl	2, 4-D	14.0	20
"	"	28.0	60
"	"	56.0	80
"	2, 4, 5-T	7.0	20
"	"	14.0	60
"	"	28.0	80
"	"	56.0	100
Butoxy Ethanol	2, 4-D	10.5	40
" "	"	21.0	80
" "	"	42.0	100
" "	2, 4, 5-T	10.5	100
" "	"	21.0	100
Propylene Glycol Butyl Ethel	2, 4-D	6.7	20
" " " "	"	17.0	60
" " " "	"	34.0	80
" " " "	"	67.0	100
" " " "	2, 4, 5- T	6.7	60
" " " "	"	17.0	100
" " " "	"	34.0	100

1/ Chemicals were applied in diesel oil November, 1949 and March, 1950.

2/ Average for winter and spring applications.

In general, CMU was effective. Best results were obtained with 80 percent powder in water solutions. On sandy type soils, 7.5 pounds per acre in 60 gallons of water has produced very satisfactory results on dense stands. However, on clay soil it appears that rates up to 15 pounds per acre will be necessary to obtain a good kill. It was most effective when placed on the soil, and in the zone occupied by the greatest amount of feeder roots. CMU is normally toxic to all plants, but established native grasses have survived and are making normal forage and seed production where rates of 15 pounds or less were applied.

Stump Treatment

This method consists of spraying both the cambium layer of wood exposed on the stumps and the bark of the stumps to the soil line. The treatments were made immediately after the top of the plant was removed. The stumps and adjacent soil areas were thoroughly wet with the spray solution or completely covered with the powdered materials. More than 500 individual stumps were treated with different chemicals. Under most conditions, it was found desirable to cut only the larger trees, and to spray the small plants with either a foliage or basal-bark treatment.

The ester formulation of 2, 4, 5-T was the best selective herbicide for spraying stumps. The concentration was 16 pounds of acid in 100 gallons of diesel oil. Ammonium sulfamate applied in the dry form or in solutions of 5 pounds per gallon of water, has given fair results. Other materials used were the chlorates and borax compounds. They were effective when applied in dry form or in solutions of 5 pounds per gallon of water. These latter compounds, however, sterilize the soil for indefinite periods.

GRASS PRODUCTION AND PASTURE DEVELOPMENT

After the brush was killed, surprisingly large yields of grass and pasture were realized. Where selective herbicides were properly used, the leaves, twigs, and stems of sprayed brush accumulated in a mulch on the soil. There was an average of 7,593 pounds per acre of this litter two years after treatment. It conserves water and makes conditions favorable for the immediate growth of native grass intermingled in the brush. Measurements made during an eight-year period on the Red Plains Station show that 45% less water ran off annually from good grass on treated land than from an adjacent area of brush land.

The success of the pasture will depend largely upon its management after the brush is removed. The soils covered with scrubby oak are usually shallow and highly erodible (2). It is, therefore, important that a continuous protective cover be maintained on this land. In order to do this, burning must be prevented.

The erodibility and fertility levels of the soils are important. Their ability to produce palatable plants can often be determined by the kind of grass intermingled in the brush. On better sites, big bluestem, little bluestem, Indiangrass, switchgrass, purple top, and sand lovegrass are usually in the undisturbed oak brush. But, due to the competition of the brush, these grasses are small, spindling, and greatly depressed in growth. The average yield of grass on fully cleared virgin land was five times that found on land 90% shaded (1).

Full grass production will be obtained more rapidly, and erosion more completely controlled, if clearing is limited to areas having only light or medium brush cover. The original grass cover is more dense on gently sloping soil where shade from woody vegetation is less. Under such conditions, a complete land cover is usually established in one or two years. There is also less likelihood of erosion starting between the time of clearing and the time the grass becomes well established. Therefore, through proper site selection and good management, the use of selective herbicides is the safest way of changing worthless brush land into valuable grass land.

These native grasses were highly nutritious and have made good pasture. Grazing studies have been made during the growing seasons of the last ten years under controlled conditions. These pastures produced an average of 70 pounds of beef per acre.

Cattle were in the experimental pastures from about May 1 to the latter part of August each year. The results of the last two years are recorded in Table 5. The highest cattle gains were obtained in 1952.

During 1952, fertilization was made a part of this experiment with native grass pastures on formerly brush land. This pasture was treated with 300 pounds of superphosphate per acre in 1952 and will be re-treated at intervals of three year periods. In addition, there was an annual spring application of 33 pounds of nitrogen per acre. The fertilized native grass produced an average of 133 pounds of beef per acre. This is about 1.6 times more than that produced on the unfertilized.

Literature Cited

1. Cox, Maurice B., and Elwell, Harry M. - "Brush Removal for Pasture improvement." Agri. Eng., Vol. 25, No. 7, pp. 253-261, July, 1944.

2. Elwell, Harry M., Daniel, Harley A., and Cox, Maurice B. - "Brush Control and Pasture Development in the Red Plains." Agronomy Journal, Vol. 42, No. 8, pp. 390-394, August, 1950.

3. Elwell, Harry M. and Cox, Maurice B. - "New Methods of Brush Control for More Grass." Journal of Range Management, Vol. 3, No. 1, pp. 46-51, January, 1950.

TABLE 5. -- Beef Production from Native Grass on Formerly Brush Land at the Red Plains Conservation Experiment Station Guthrie, Oklahoma

Pasture No.	Kind of Fertilizer Pounds Per Acre[1]/	Grazing Season	No. of Grazing Days[2]/	Beef Pounds Per Acre
7	None	1952	121	96
"	"	1953	130	73
		Average	125	84[3]/
8	100-(0-20-0)-33-N	1952	121	134
"	"	1953	130	132
		Average	125	133

1/ Superphosphate applied at the rate of 300 pounds per acre every third year in furrows about four inches deep and thirty inches apart, as the sod was split with a Pasture-Dream distributor. This is the equivalent of 100 pounds per acre annually. Nitrogen was applied to the surface during the last week in May.

2/ Grazing period in 1952 started May 1 and ended August 29. Grazing period in 1953 started April 24 and ended August 31.

3/ Average of ten years was 70 pounds per acre.